Development of a Strontium Iodide Coded Aperture Instrument

by

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Introduction

- Development towards Coded Aperture System for short gamma-ray burst (sGRB) detection and localization
  - Wide Field of View (90 deg - fully coded)
  - Imaging energy regime 20-600 keV
  - Detection up to 1 MeV
  - Reduced SWAP to increase mission opportunities
- Space Test Program (STP) - is the primary provider of spaceflight DOD space science and technology community.
  - International Space Station
  - Secondary payloads
  - Dedicated launch services.
- Strontium Iodide Radiation Instrument (SIRI)
- Proposed Development of Prototype Strontium Iodide Coded Aperture (SICA) array
- Full-sized Instrument (SICADA)

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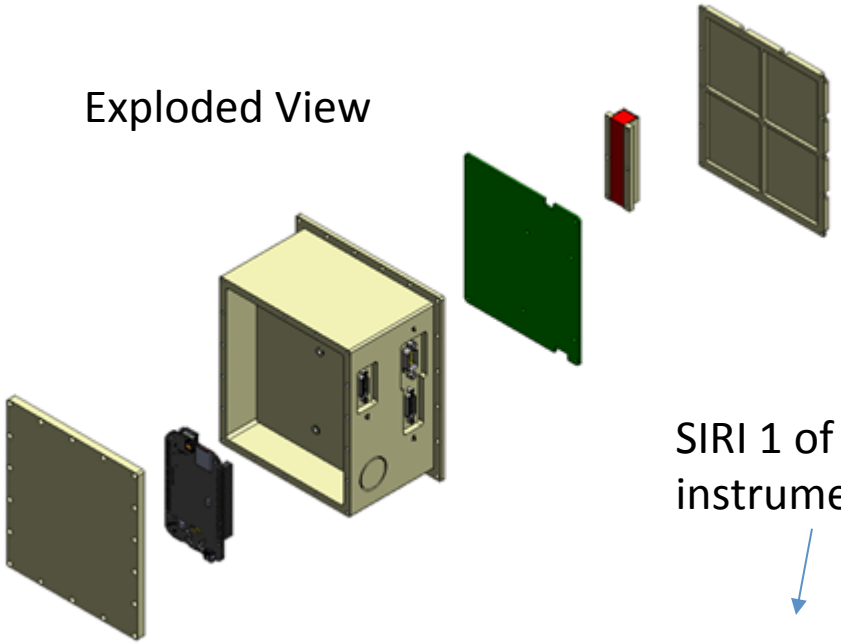
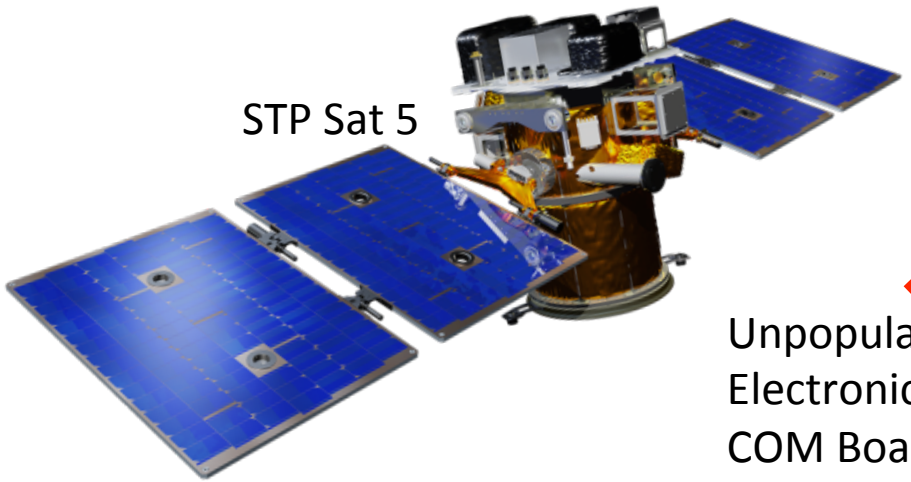
Strontium Iodide Radiation Instrument (SIRI)

Exploded View



SIRI 1 of 5 instruments

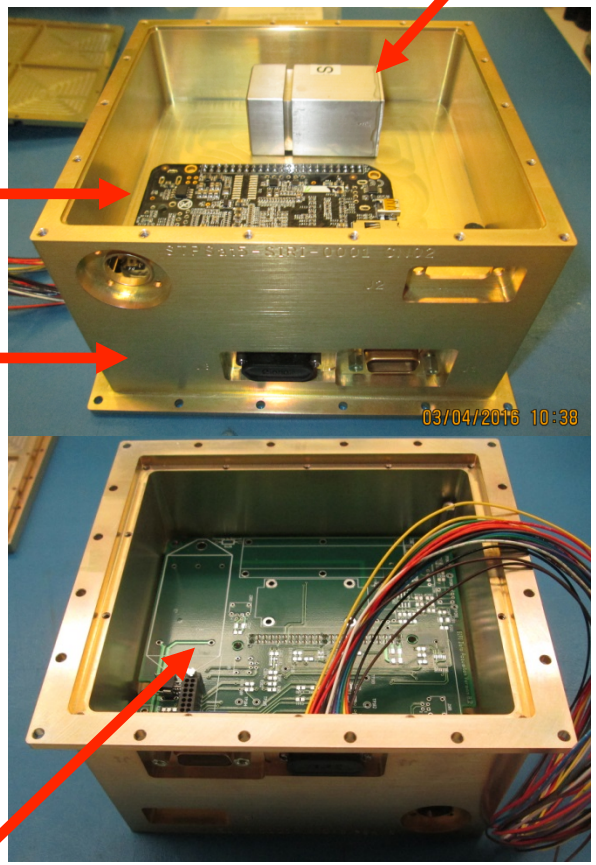
STP Sat 5



Detector

SBC

Housing



Unpopulated Electronics/ COM Board

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Strontium Iodide Radiation Instrument (SIRI)

- Instrument Description
  - Single RMD SrI_2:Eu detector (17 x 17 x 40)mm^3
  - SensL 2x2 J-series SiPM array
  - low power COTS MCA (Kromek) and SBC (BeagleBone Black)
  - time stamped event data
- Objectives
  - Study the internal activation of the SrI_2:Eu in a space environment (altitude ~ 500 km)
  - SiPM performance and degradation over 1 yr mission life
- Current Schedule
  - Instrument assembly and GEVS testing (next few months)
  - Spacecraft integration begin summer 2016
  - Launch summer 2017, Falcon 9, ESPA ring

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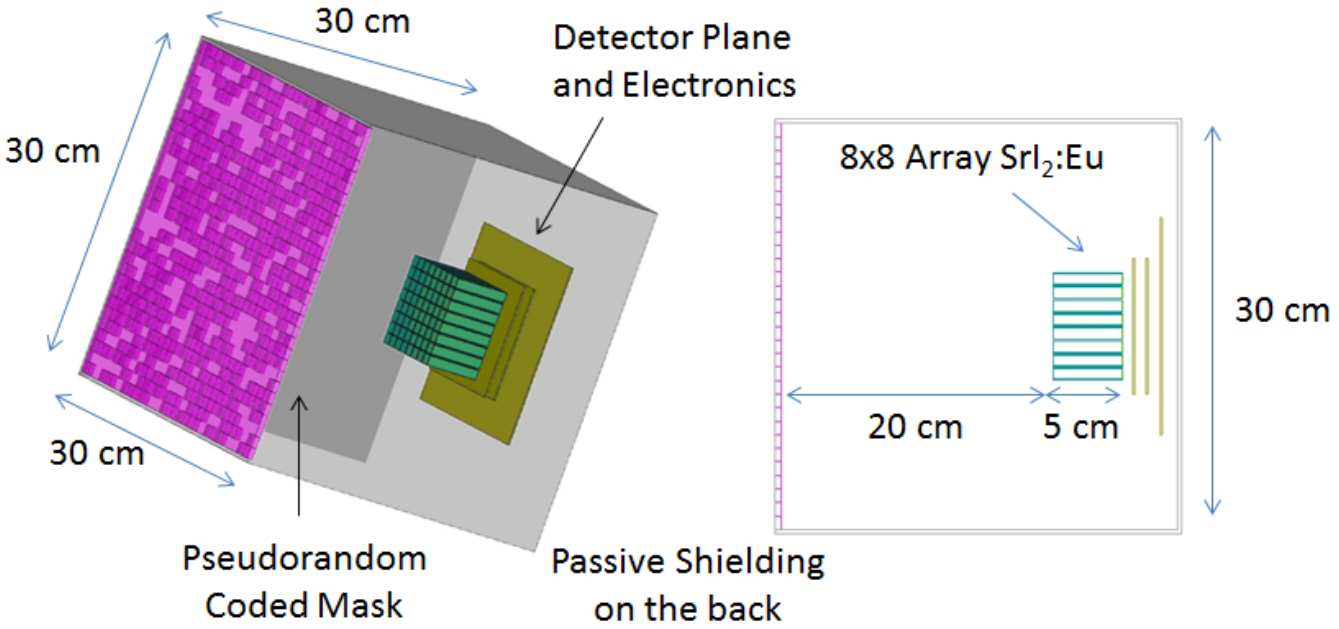
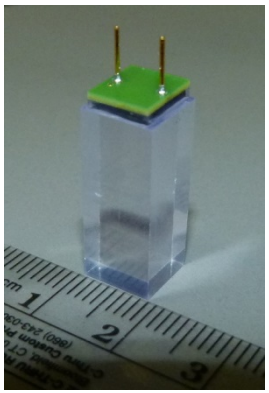
Strontium Iodide Coded Aperture





Test detector
Crystal and SiPM

27U cube

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SICA prototype

- Objectives
  - sGRB detection and imaging
  - in the FCFOV Rate 2-3/yr
  - Small instrument increases likelihood of STP selection
  - 3 years from start to launch
  - Reasonable position accuracy
  - Imaging regime (20 – 600 keV)
- Description
  - Detector Plane – 8 x 8 array of SrI_2:Eu 3.2%@662 keV (pitch 1.0 cm)
  - Each Detector - 0.8 cm x 0.8 cm x 5cm
  - Mask – Tantalum 30 x 30 each element (1cm x 1cm x 0.5cm)
  - COTS electronics, with some custom main boards
  - Mask 20 cm from detector plane
  - Fully Coded Field of View (FCFOV) = 58^o
  - Angular Resolution (AR) = 2.9^o
  - Power = 13W

Note: Position accuracy = AR/SNR

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Strontium Iodide Coded Aperture Detector Array (SICADA)

- Full Sized version of (SICA)
- Objectives
  - Increased sGRB detection rate (~8/yr) over the prototype
  - Improved positional accuracy
  - Energy regime 20 keV – 600 keV
  - Larger instrument with background rejection
  - SWAP and costs start limit mission options
- Description
  - Detector Plane - 40 x 40 array pitch=1cm thickness 5cm
  - Mask Titanium 108 cm x 108 cm x 0.5cm (pitch 1cm)
  - Larger number of channels (more custom electronics required)
  - FCFOV = 90^{o}
  - AR = ~2.0^{o} (20 arcmin for a 6 sigma detection)
  - Mass ~ 300 kg
  - Power 20-30W
  - Active BGO shield on back and sides of detector plane

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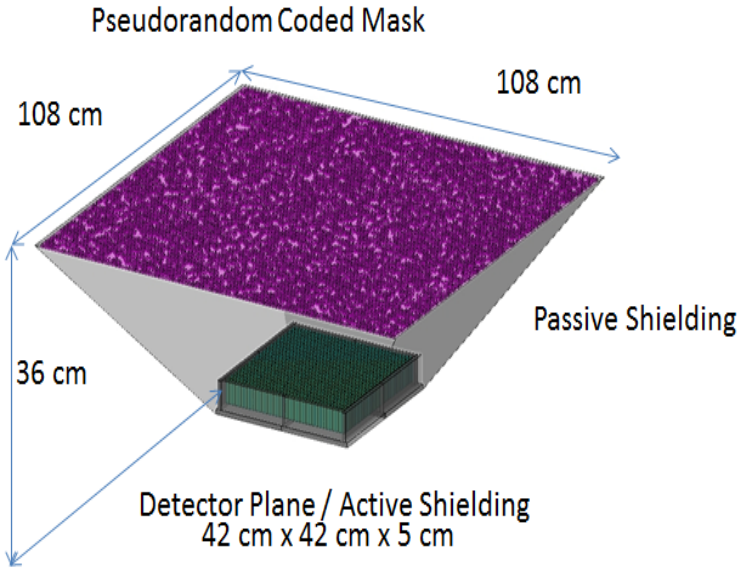
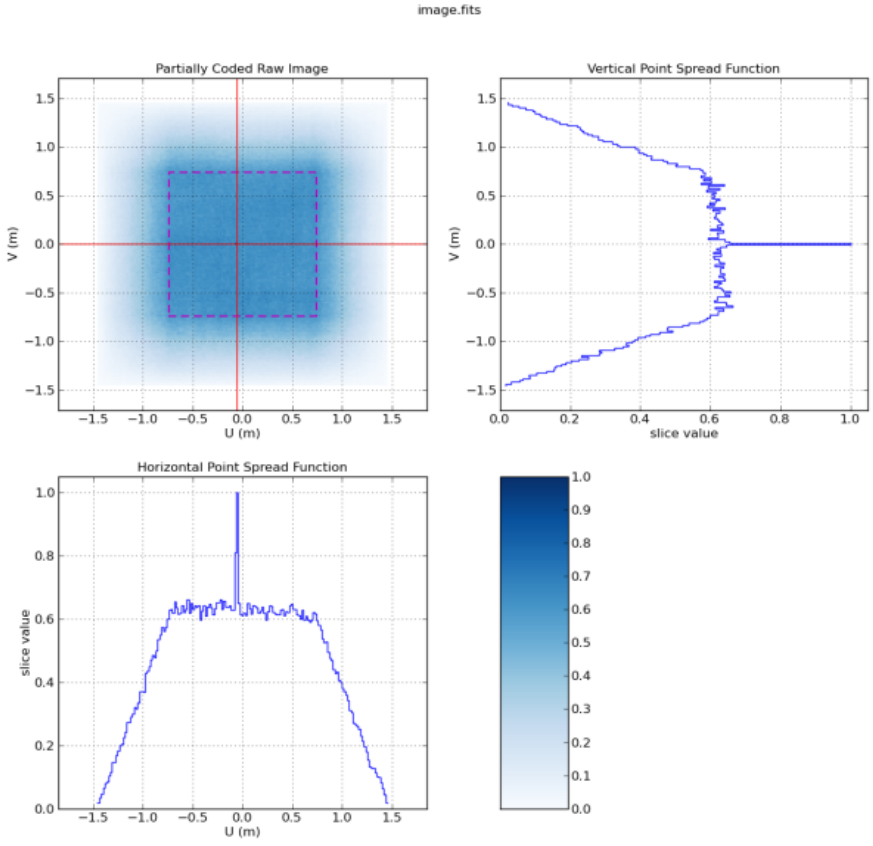
Strontium Iodide Coded Aperture Detection Array (SICADA)

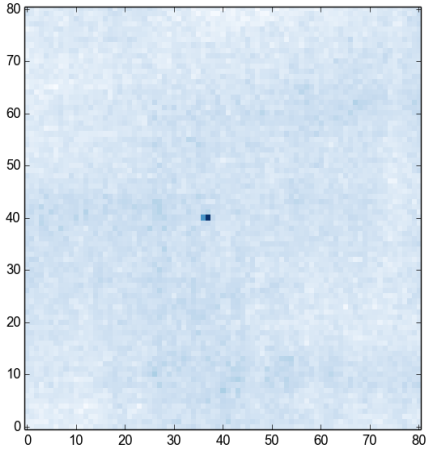




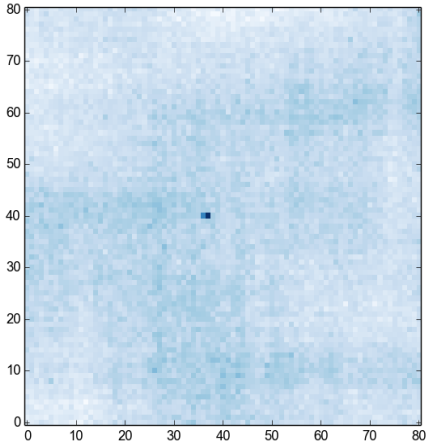
SICADA Simulations

- Simulated 1 photon/cm^2 sGRB 5^o off axis
- Added internal background (due to activation)
- Need to add galactic diffuse and albedo background contributions

Without internal background



With internal background



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Conclusion

- The duration of sGRBs ($T_{90} < 2s$) associated with LIGO type events requires wide FOV for detection.
- A small instrument such as SICA would allow us to rapidly get something into the STP queue
- A larger more sensitive instrument (SICADA) is ideal but larger SWAP limits mission opportunities and increases cost

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